

Reference Case Energy and Emissions Forecast for Vermont

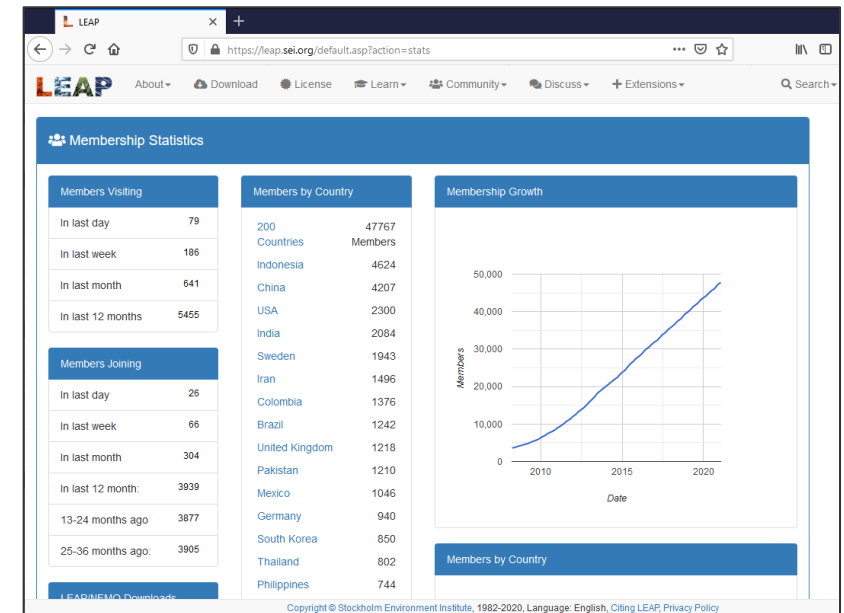
Taylor Binnington *Scientist, Energy Modeling Program*

Modeling Tool

- **Low Emissions Analysis Platform (LEAP)**
 - A software tool for **quantitative modeling** of:
 - Energy systems
 - Pollutant emissions from energy and non-energy sources
 - Health impacts
 - Sustainable development indicators
 - Costs and benefits
 - Related externalities
 - Created by an SEI team based in Somerville, Mass.
 - Distinguished by **data and methodological flexibility**, **graphical user interface**, built-in **accounting features** (energy, emissions, costs, natural resources)
 - **Thousands of users** in over 190 countries

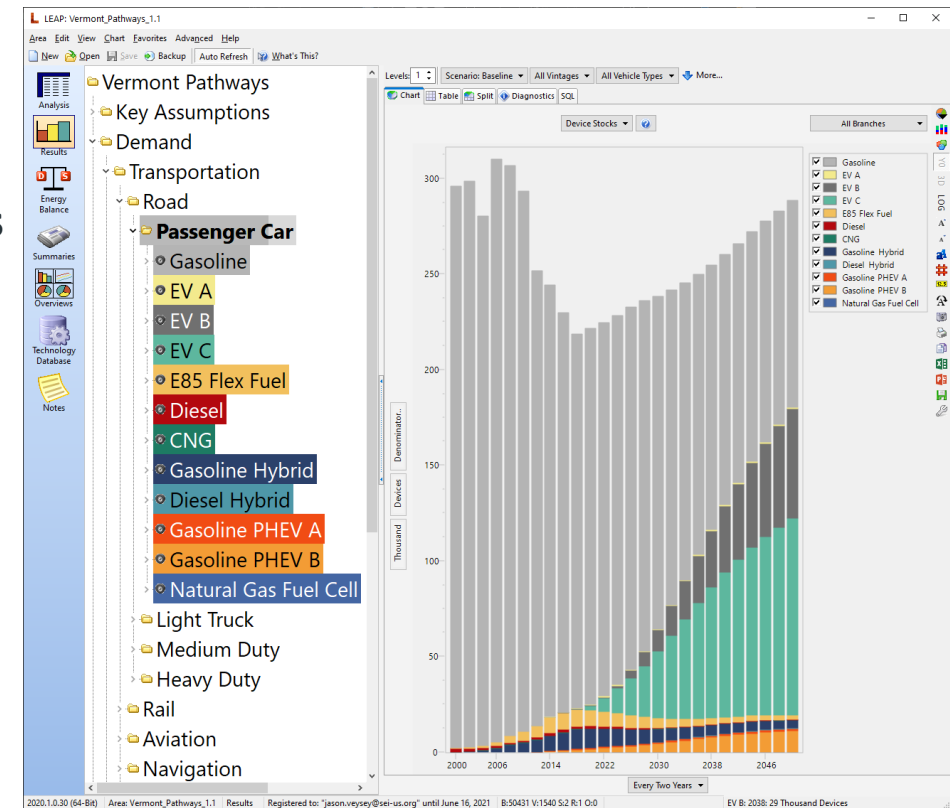


<https://leap.sei.org>



Model Scope and Methods

- Modeling period: **2015-2050**, with scenario(s) beginning in 2020
- Model covers **all energy demand, energy supply, and GHG emissions in Vermont** (all sectors including emissions from **energy and non-energy** sources)
- GHG emissions converted to **CO₂-equivalent** using 100-year global warming potentials from Intergovernmental Panel on Climate Change's **Fourth Assessment Report**



Model Development Process

Scenarios

Historical energy
flows

Reference case
projection

Mitigation
scenarios

Mitigation
pathway(s)

Scope

Final energy demand

“Simple” energy
supply

Electric capacity and
dispatch

Energy-related emissions

GHGs

Other air pollutants

Criteria pollutants

Non-energy emissions

Historical emissions

Simple trend
projection

LULUCF

Costs

Fuel costs

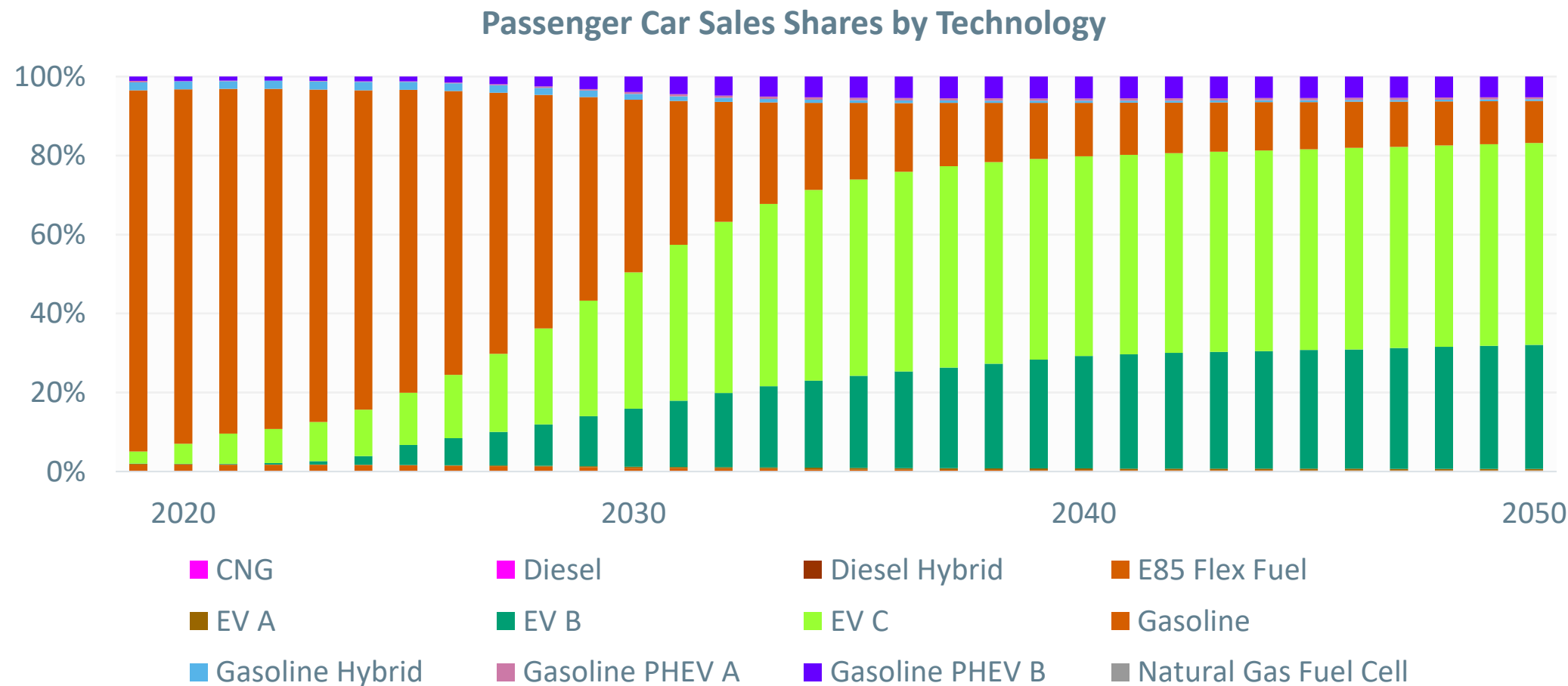
Investment and other mitigation
policy costs

On-Road Transportation

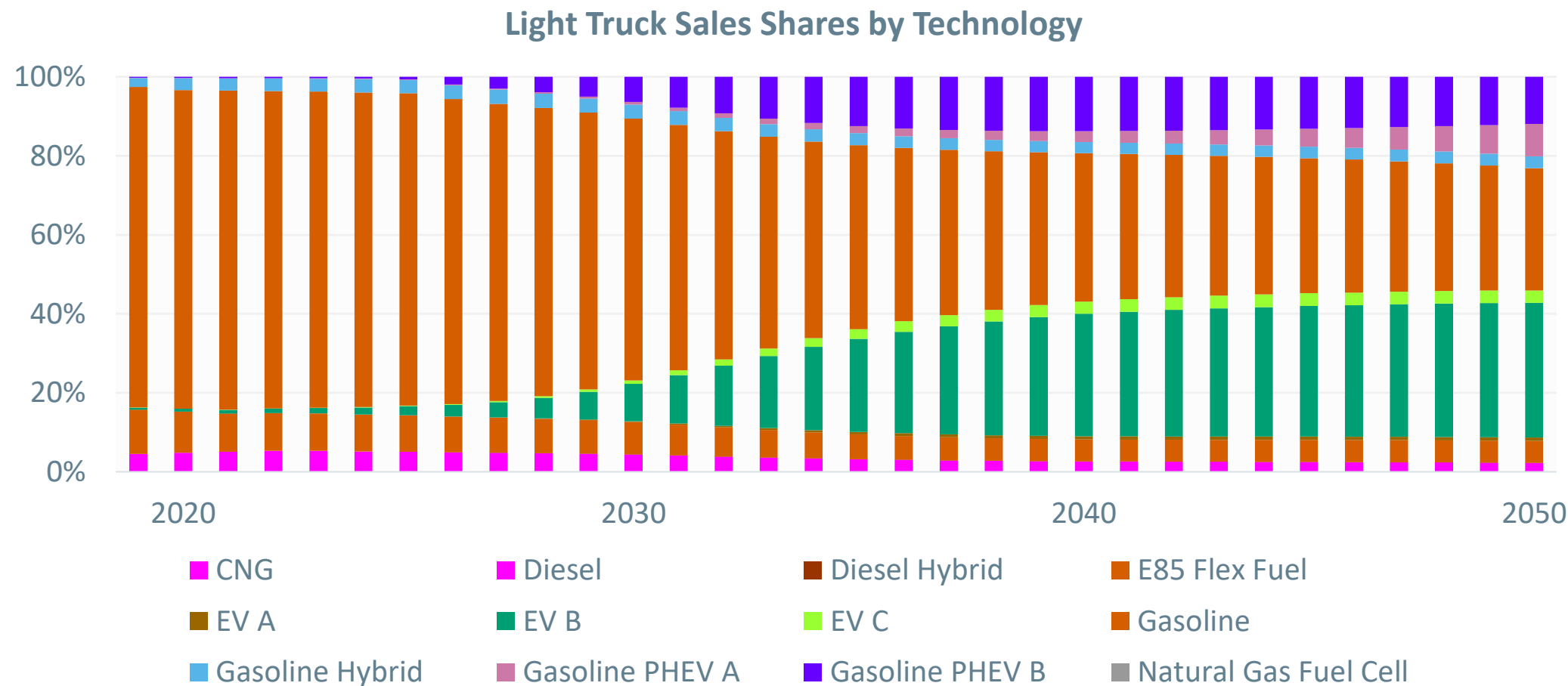
What's Included?

- Registrations of publicly and privately owned road vehicles from VDMV
- Historical vehicle registrations from UVM TRC (Dowds) and FHWA
- Historical and forecasted VMT from UVM TRC (Sullivan)
- Fuel economy and mileage over vehicle lifetime from VISION 2020 model, including ethanol and biodiesel blends
- EV sales from VELCO (light-duty) and multi-state MOU (medium- and heavy-duty)
- Other vehicle sales forecasts aligned with AEO 2020
- GHG emissions from EPA's SIT and GREET

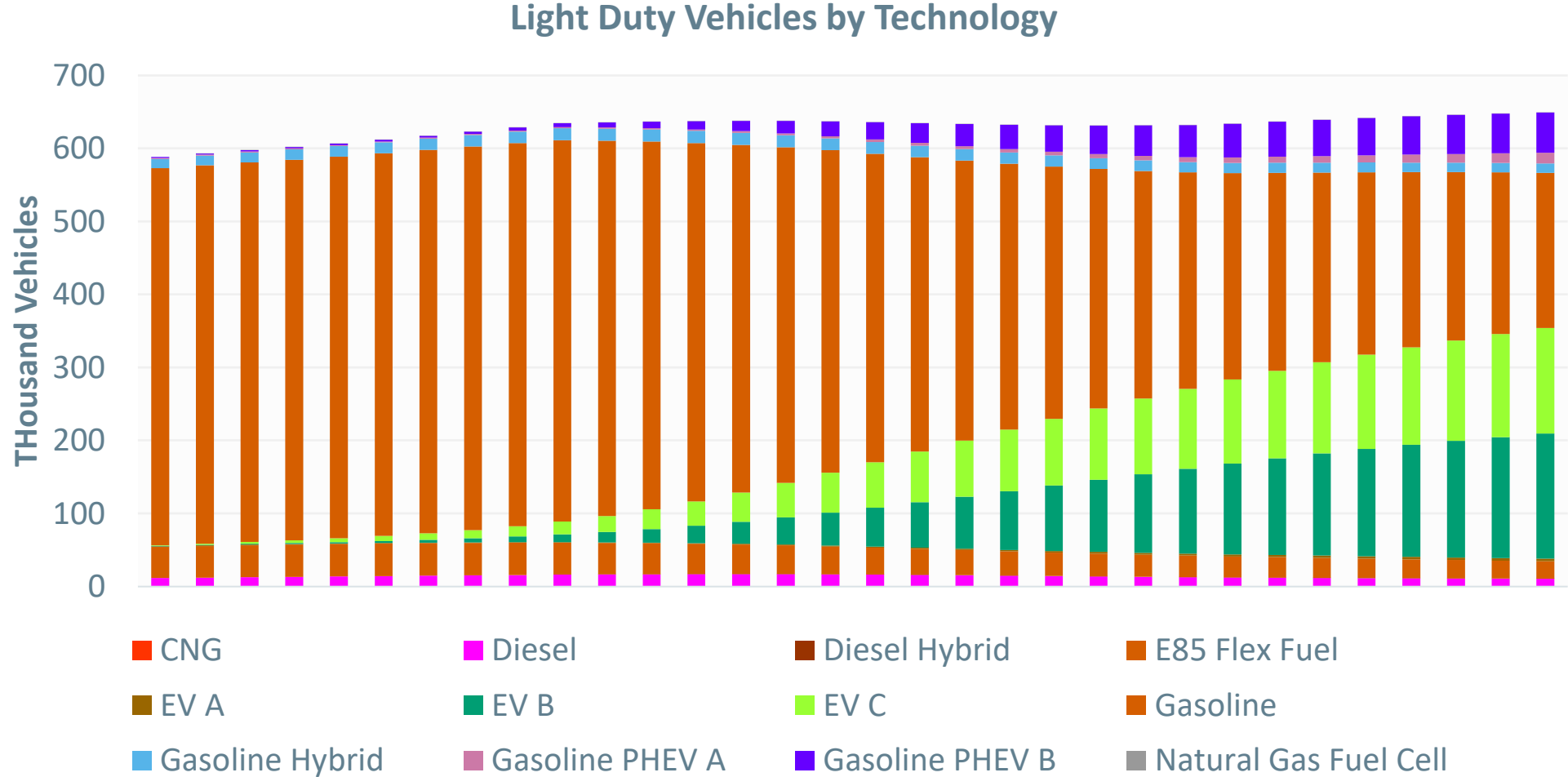
On-Road Transportation: Reference Case Results



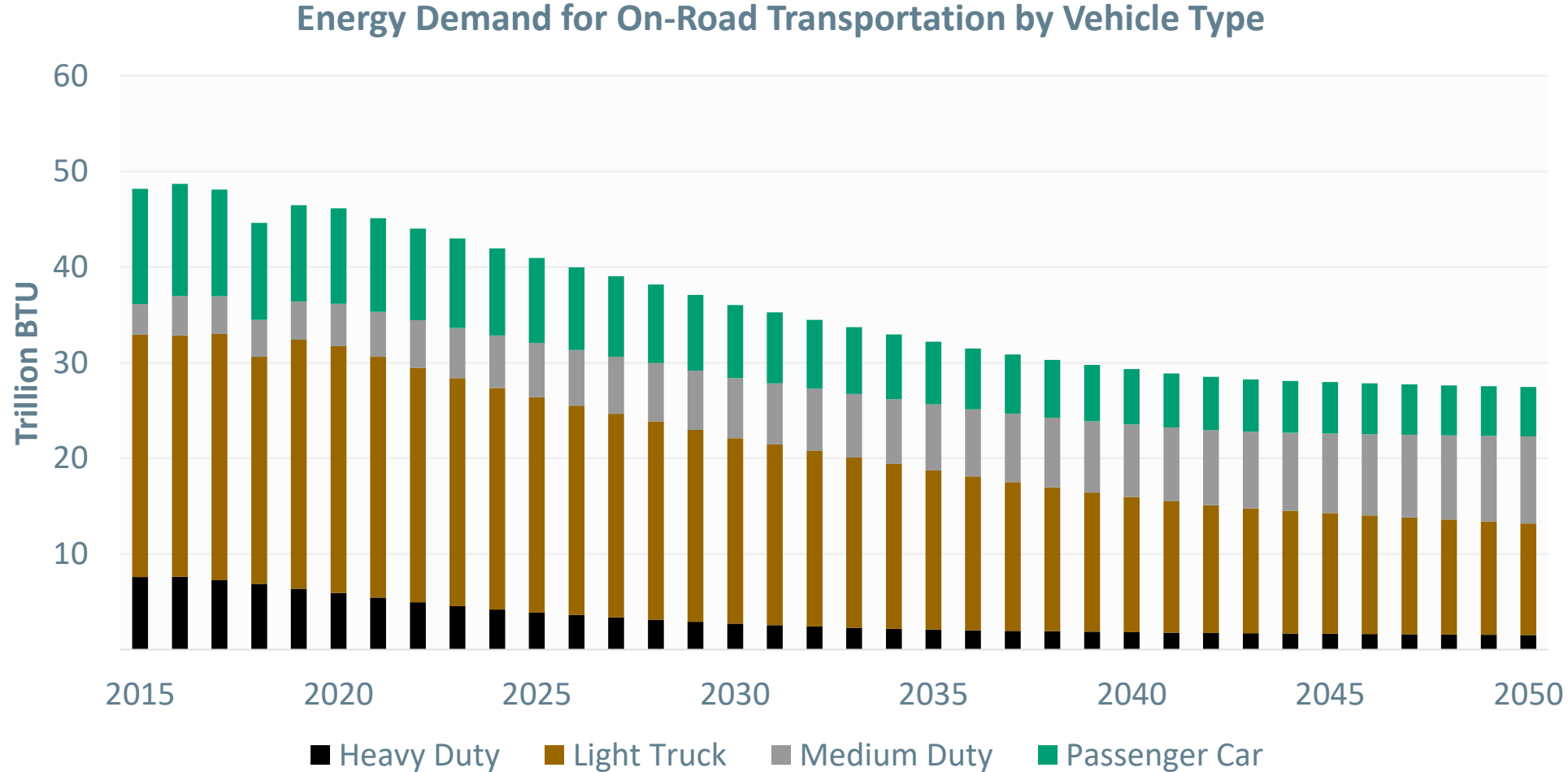
On-Road Transportation: Reference Case Results



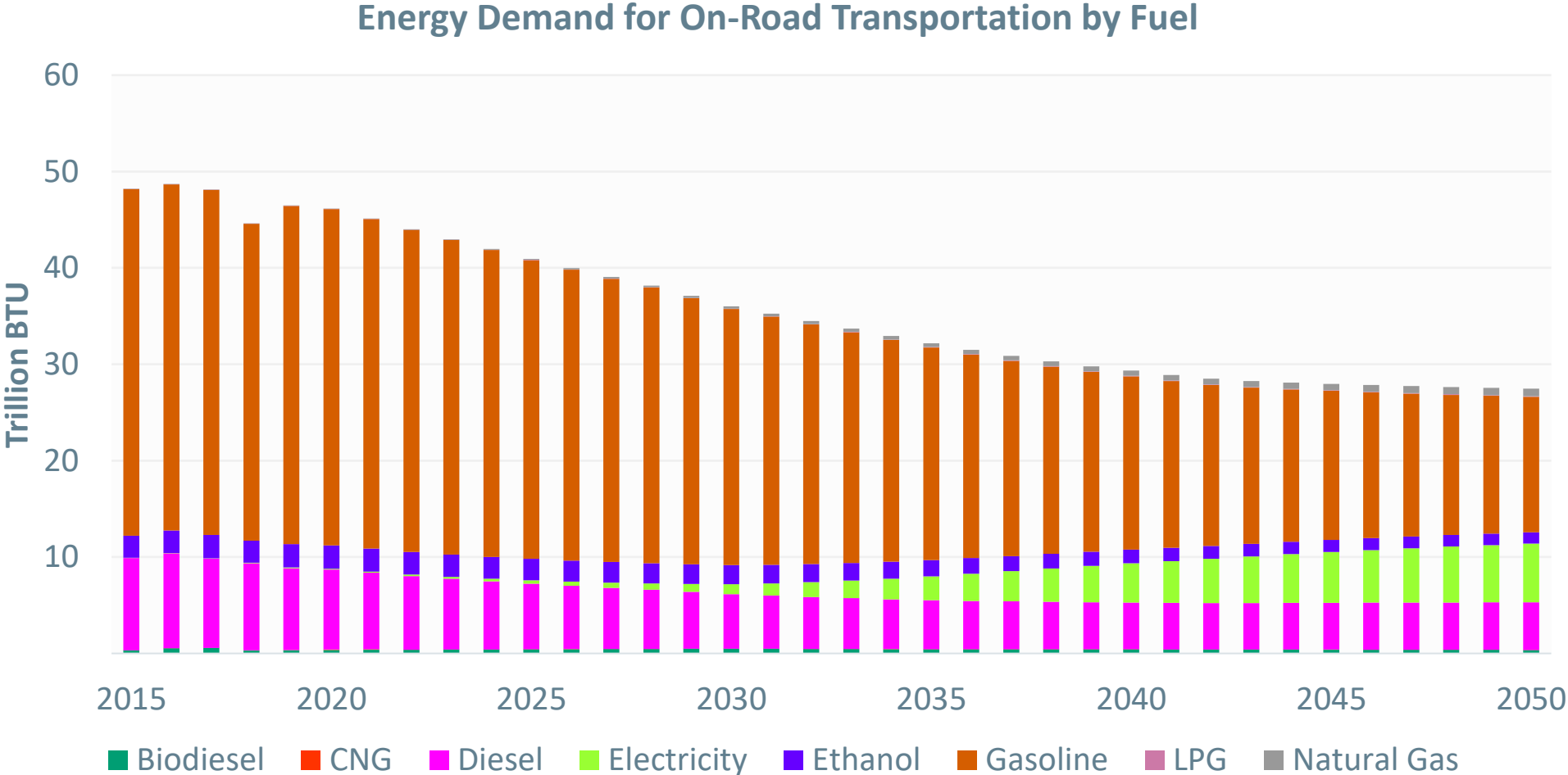
On-Road Transportation: Reference Case Results



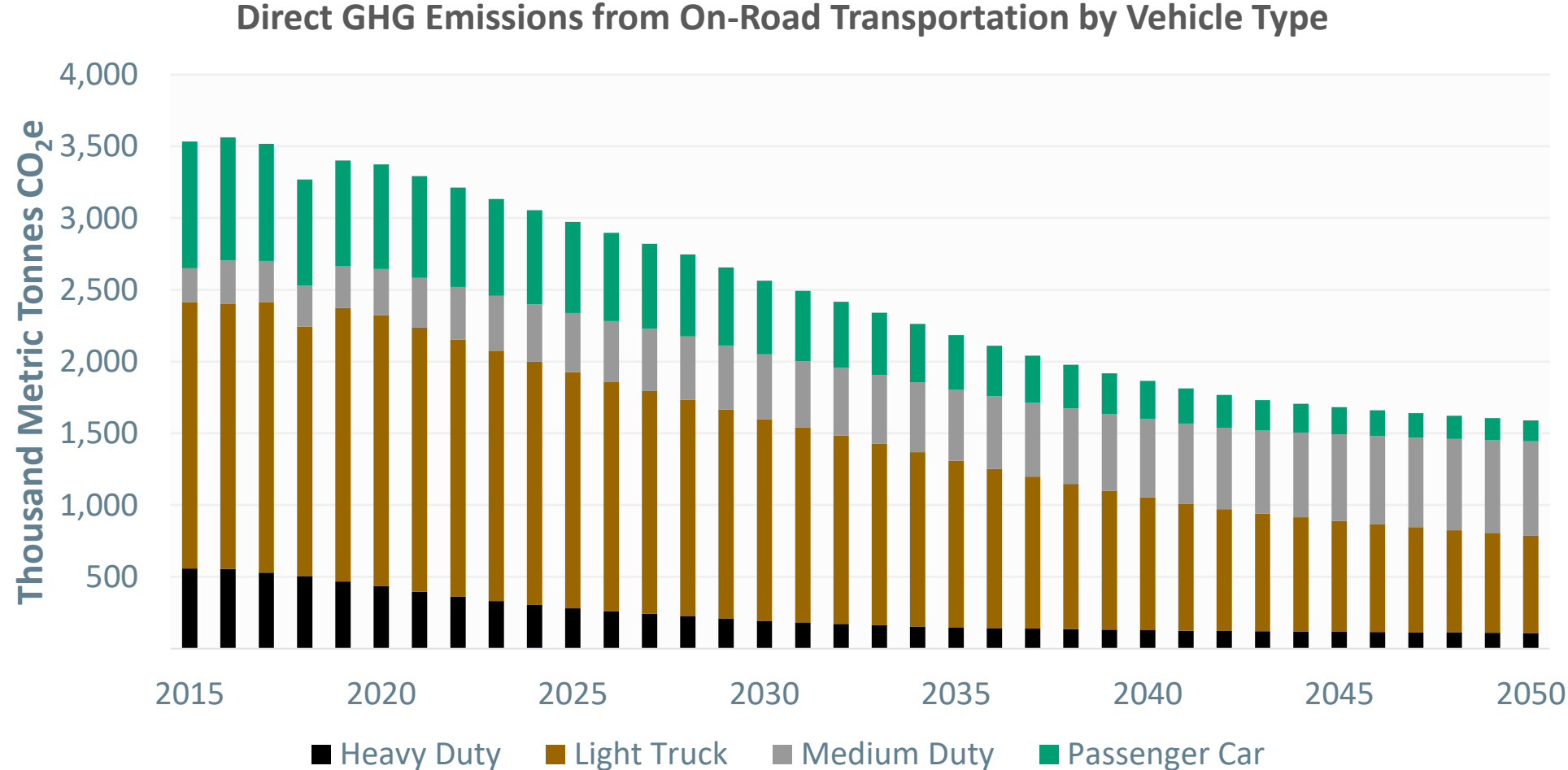
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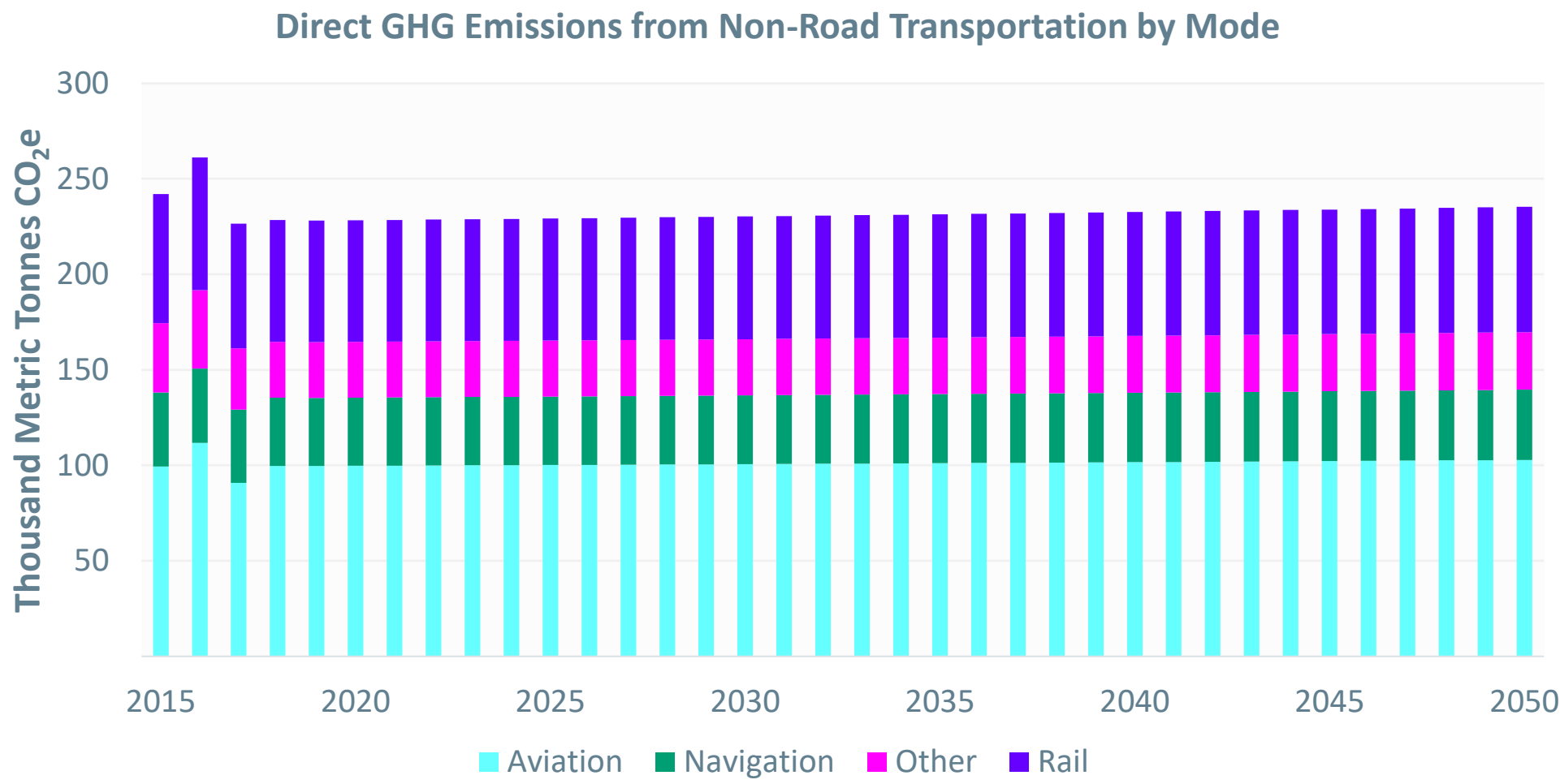


Non-Road Transportation

What's Included?

- Historical and forecasted rail, aviation, navigation, “other” fuel shares from AEO 2020
- Total energy consumption per capita derived from SEDS, and population forecasts from VT DOH and UVM TRC
- GHG Emissions from EPA's SIT

Non-Road Transportation: Reference Case Results

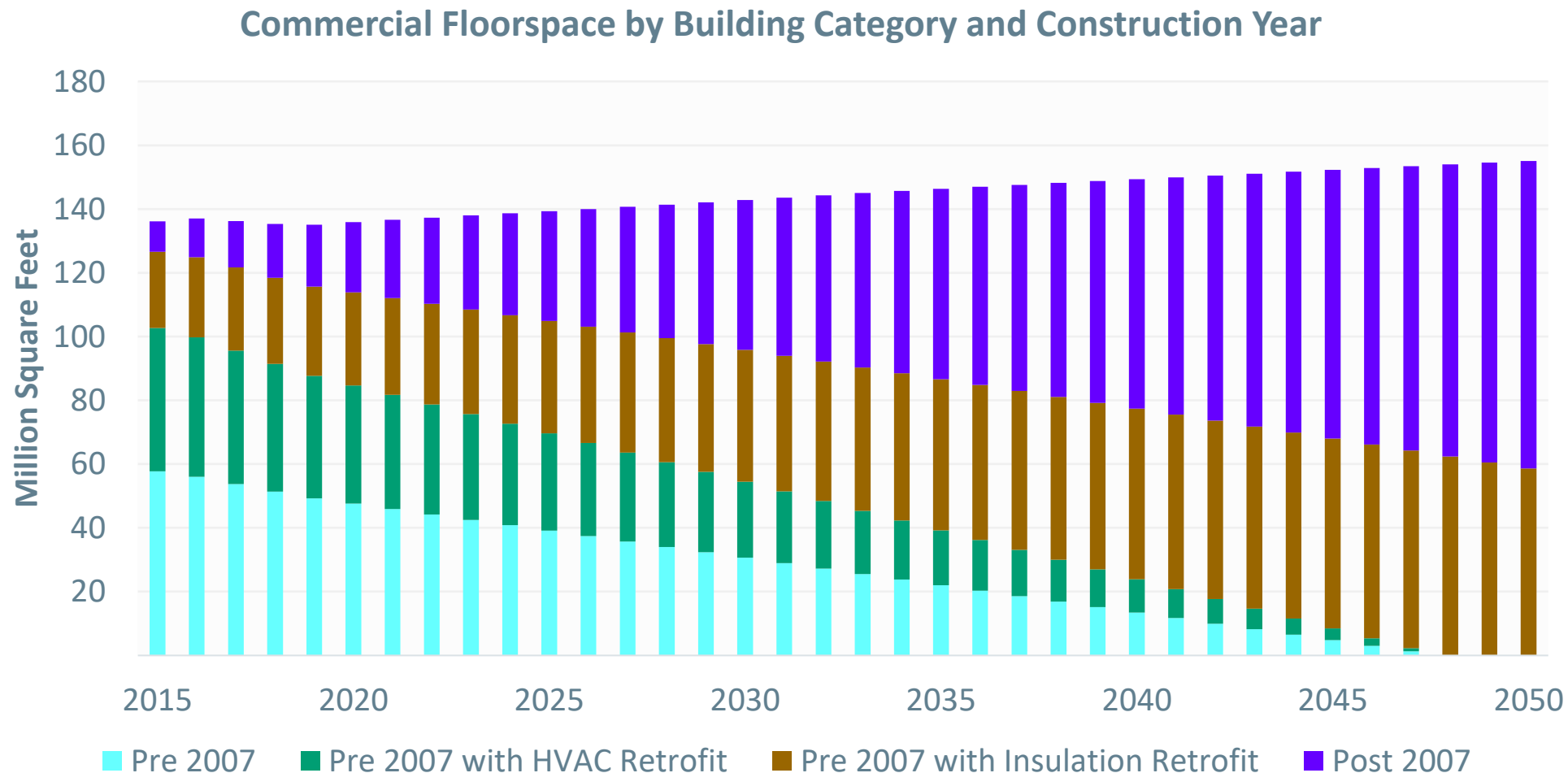


Commercial Buildings

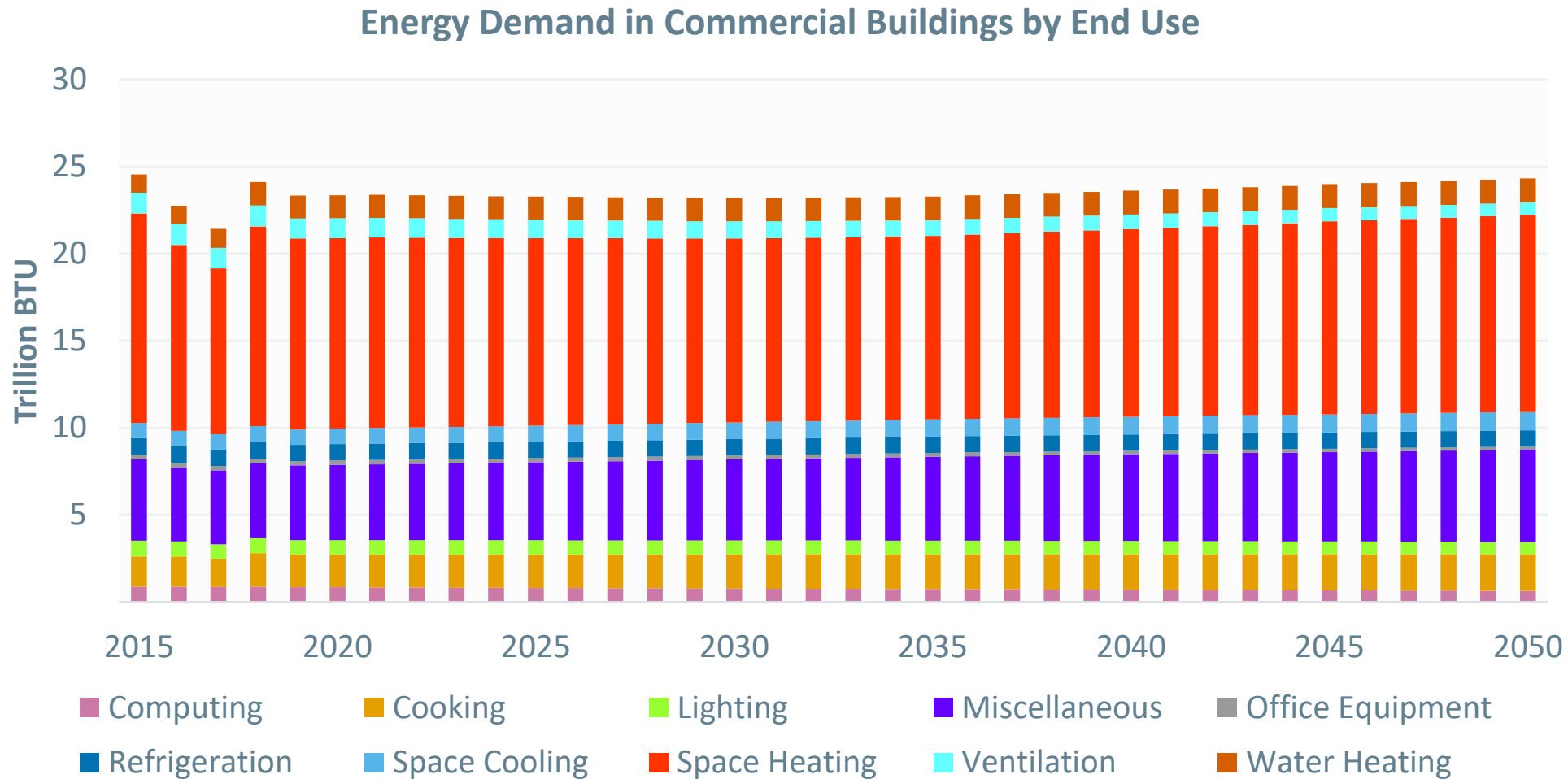
What's Included?

- Based on EIA CBECS
 - Floorspace for “pre-2007” buildings without retrofits, with HVAC retrofit, with insulation retrofits, “post-2007” buildings
 - Within each, penetration of different building technologies and energy use per square foot
 - Floorspace projections from AEO 2020 for New England, prorated for Vermont GDP from US BEA
- Adjustments to technology shares within space heating, lighting, water heating from PSD/Cadmus
- Estimated annual heat pump additions from VELCO/Itron
- Energy efficiency program thermal fuel savings and declining electricity use per square foot from EVT, total natural gas efficiency from Vermont PUC
- GHG emissions from EPA's SIT

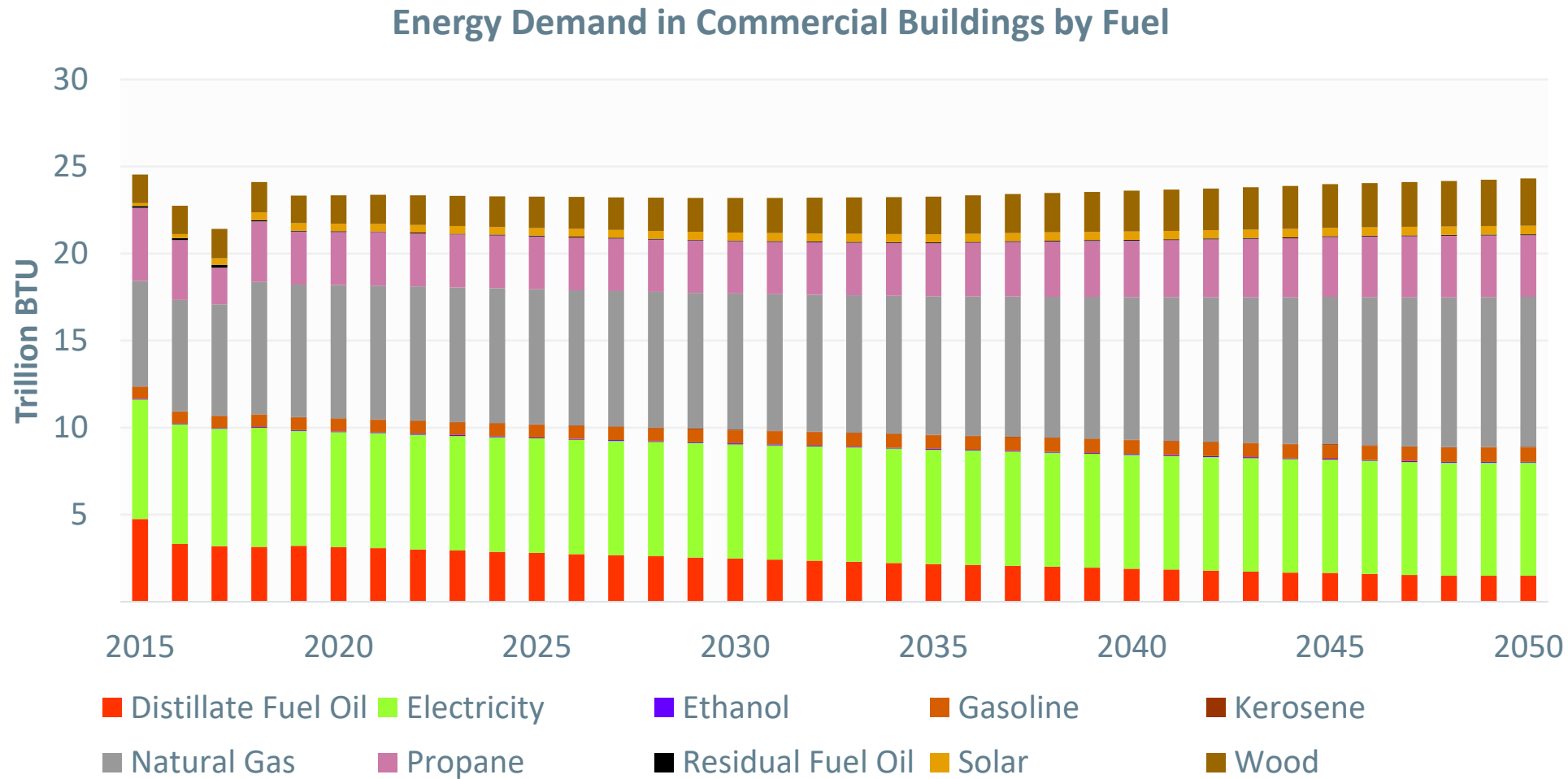
Commercial Buildings: Reference Case Assumptions



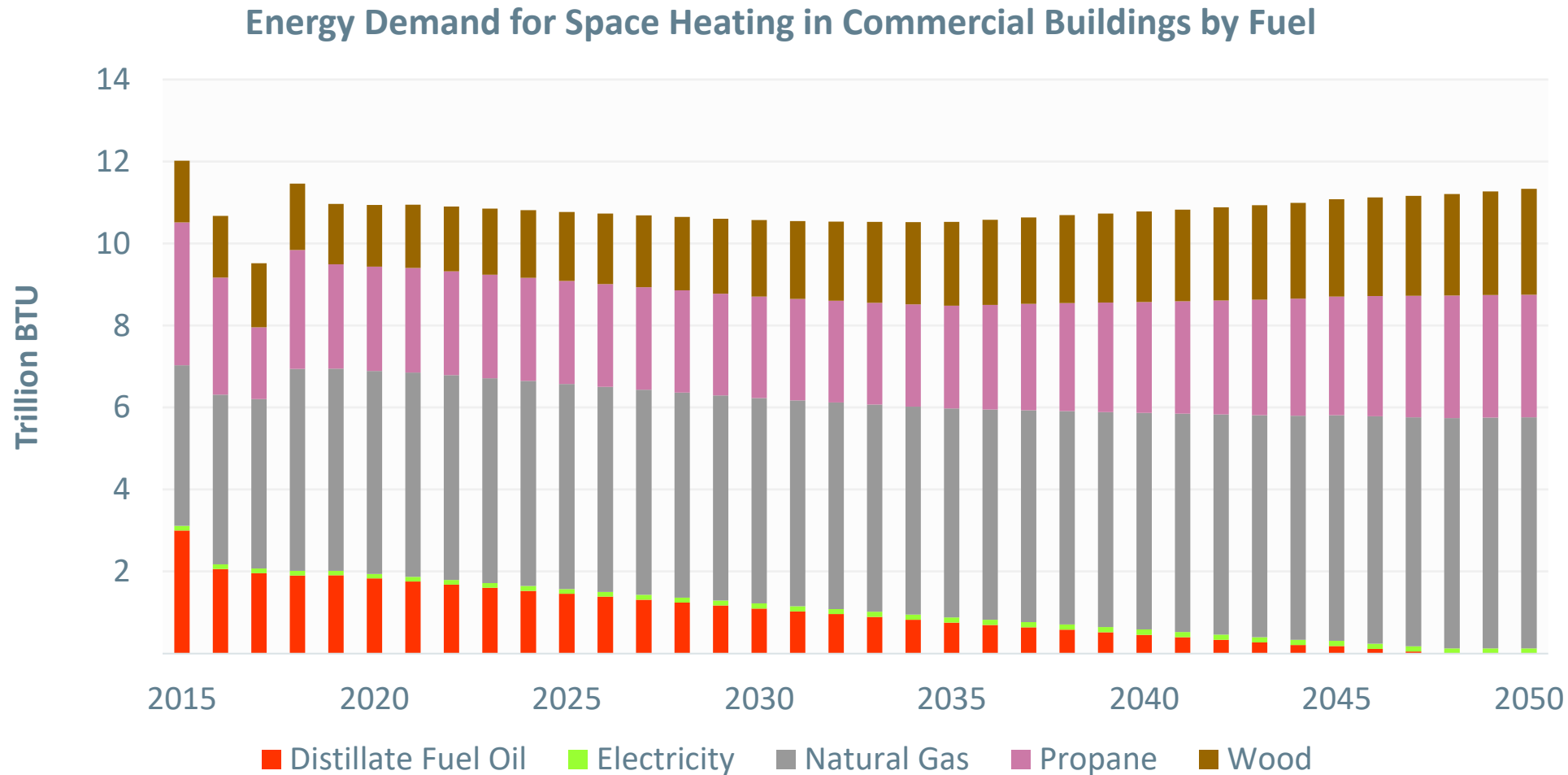
Commercial Buildings: Reference Case Results



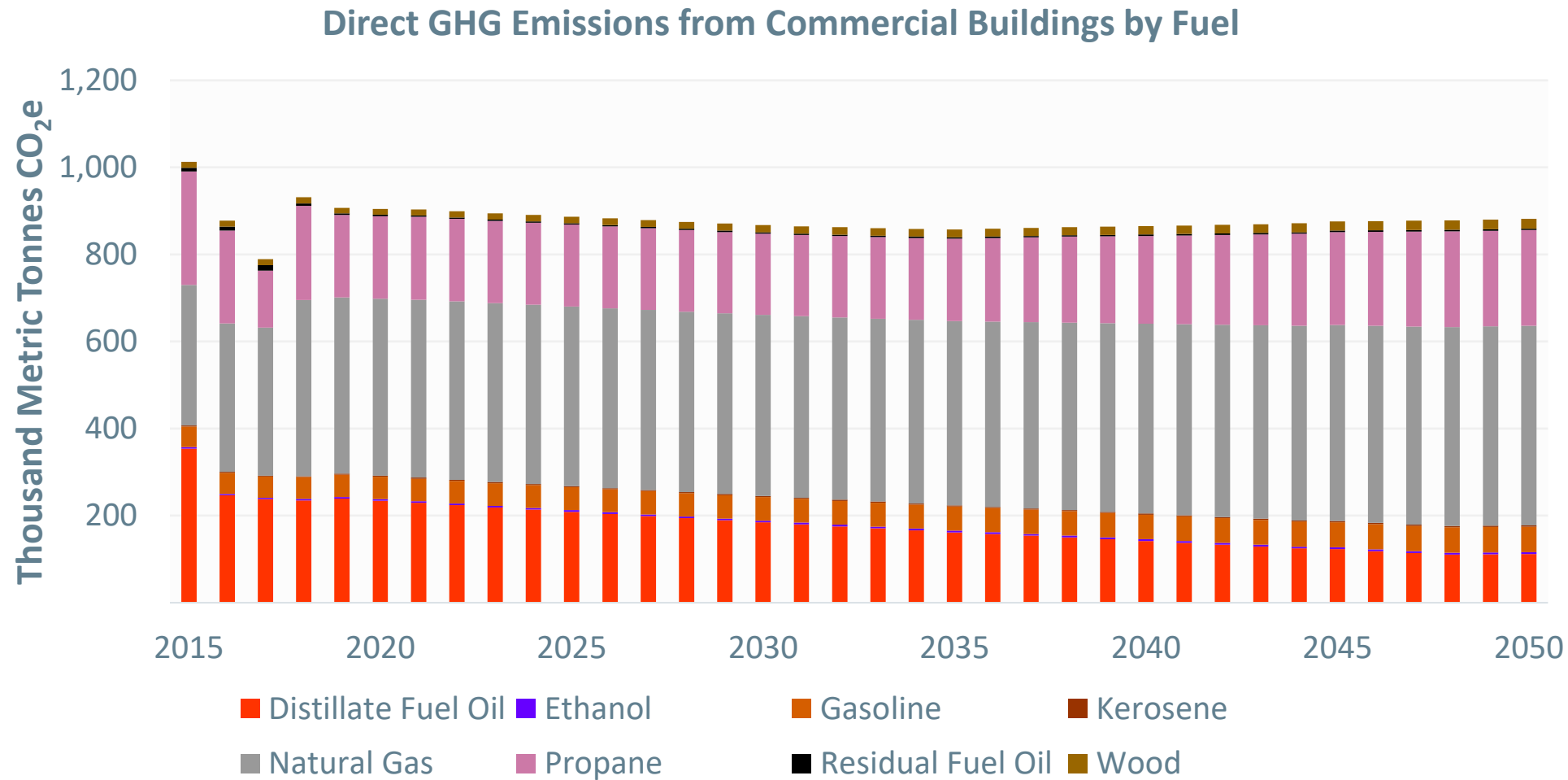
Commercial Buildings: Reference Case Results



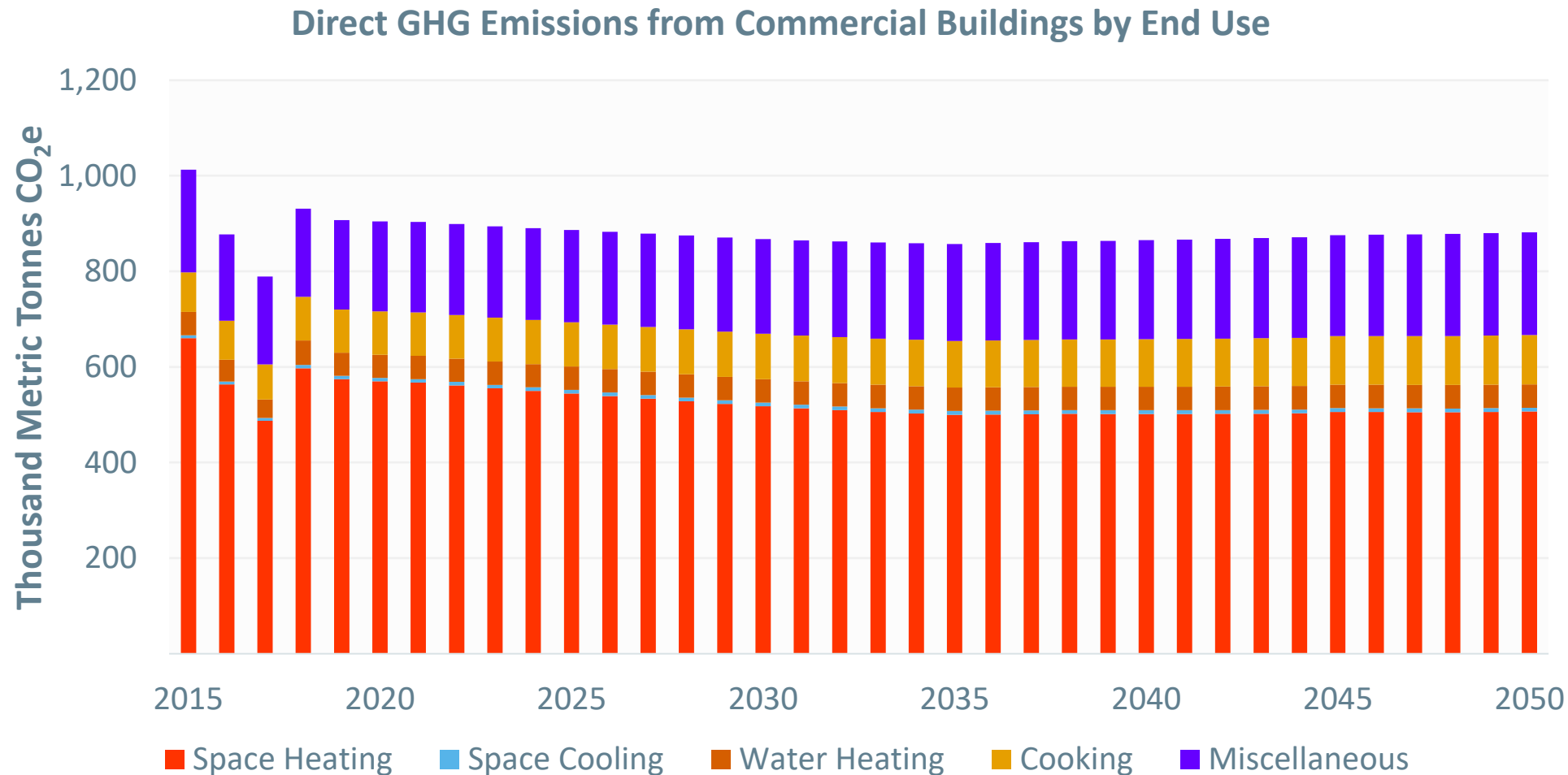
Commercial Buildings: Reference Case Results



Commercial Buildings: Reference Case Results



Commercial Buildings: Reference Case Results



Residential Buildings

What's Included?

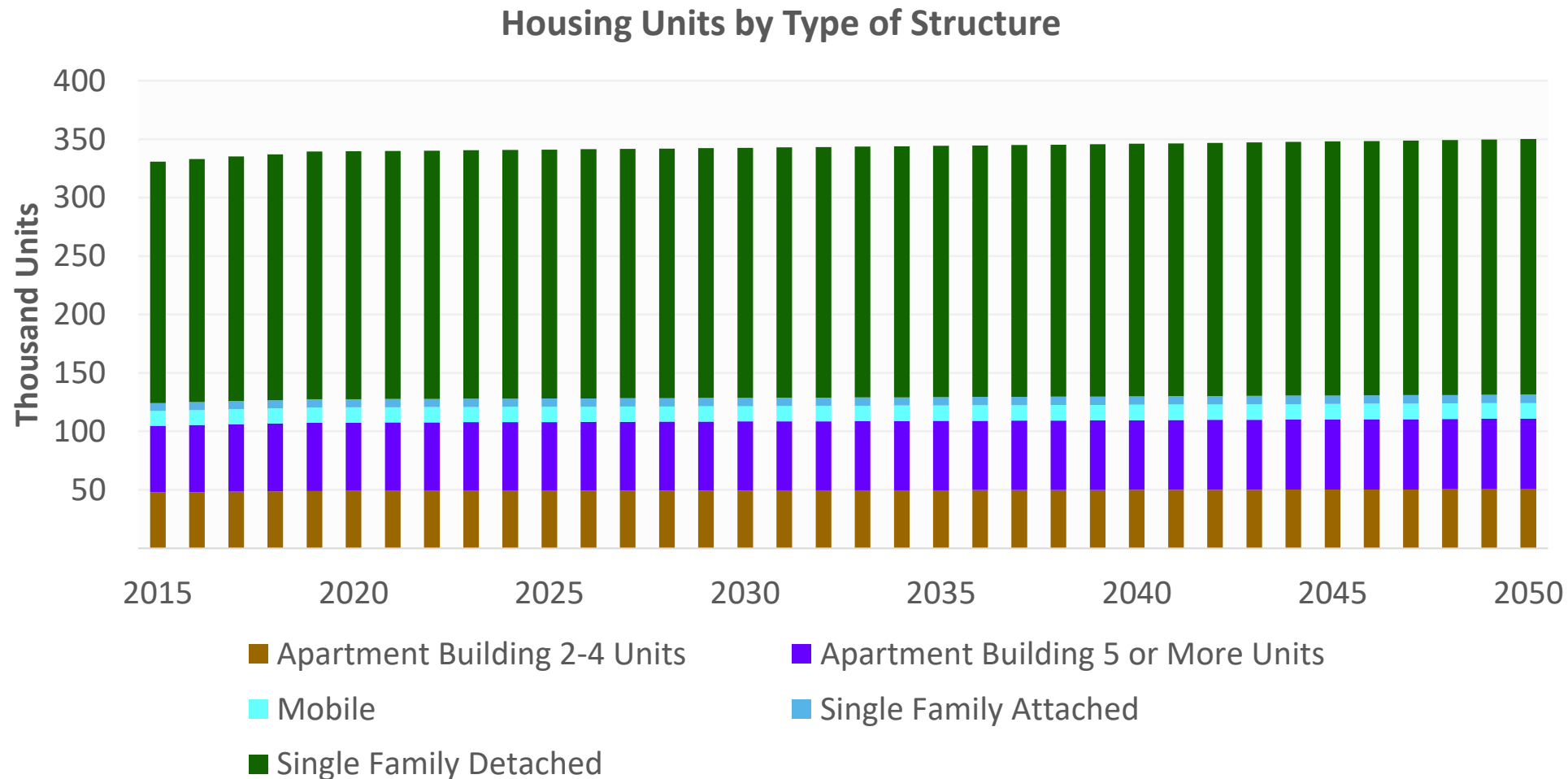
- Based on EIA RECS
 - Includes shares of housing units in urban vs. rural areas, by housing type and tenure, having different energy end uses and technologies
 - Technology and end use penetrations from VT Residential Market Assessment and RECS
 - Equipment efficiencies from RECS and VT Residential Market Assessment
 - Total housing units from Census Bureau, population forecast harmonized with UVM TRC
 - VT Residential Fuel Assessment: wood and pellet consumption in Vermont
- VT Residential Market Assessment: technology penetration in new housing units
- Projected energy efficiency program savings by end use from EVEC
- Projected building shell retrofits (weatherization) from EVR and VGS, with building shell improvements in new construction from PSD/EVEC

Residential Buildings (continued)

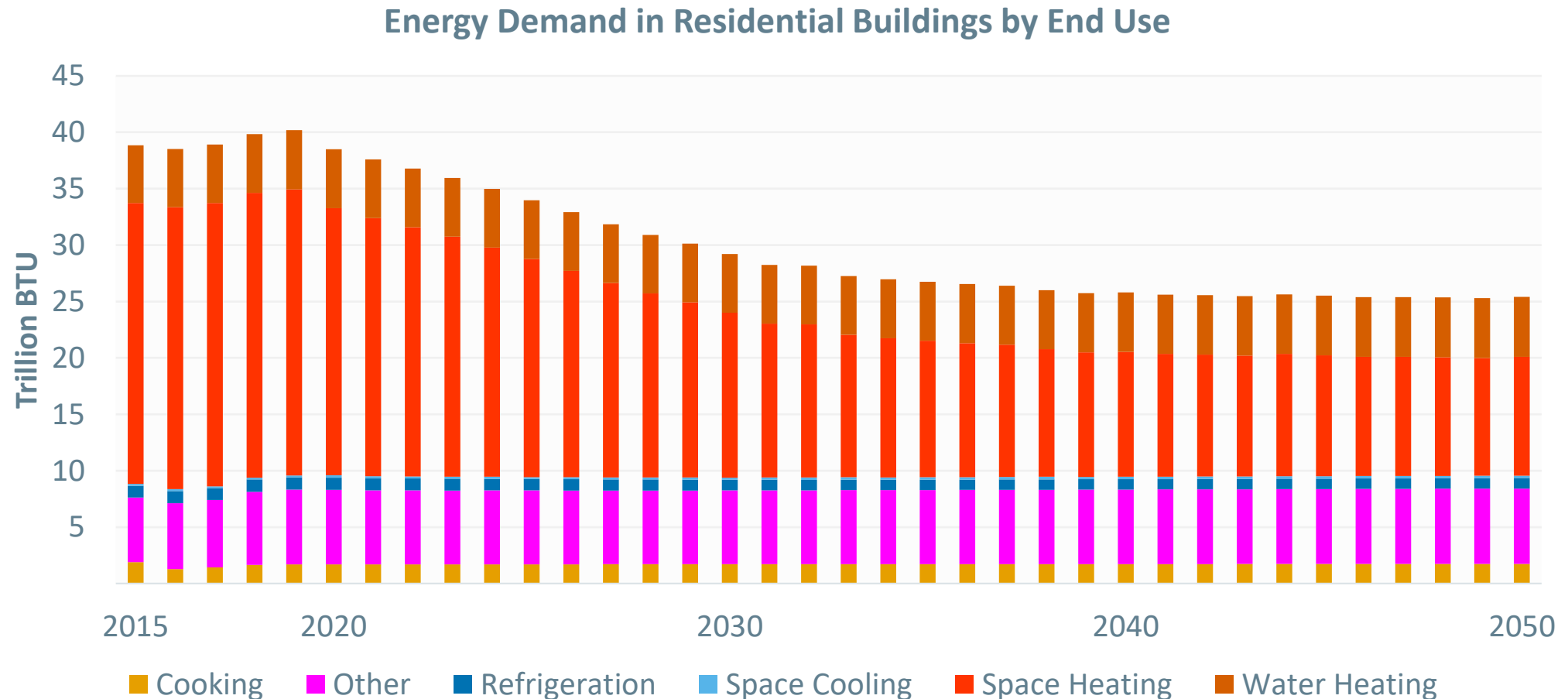
What's Included?

- Changes to HDD and CDD from Northeast Regional Climate Center
- Projected changes to device efficiencies, and changes in shares of households using different cooking technologies from AEO 2020
- Estimated annual heat pump additions from VELCO/Itron
- GHG emissions from EPA's SIT

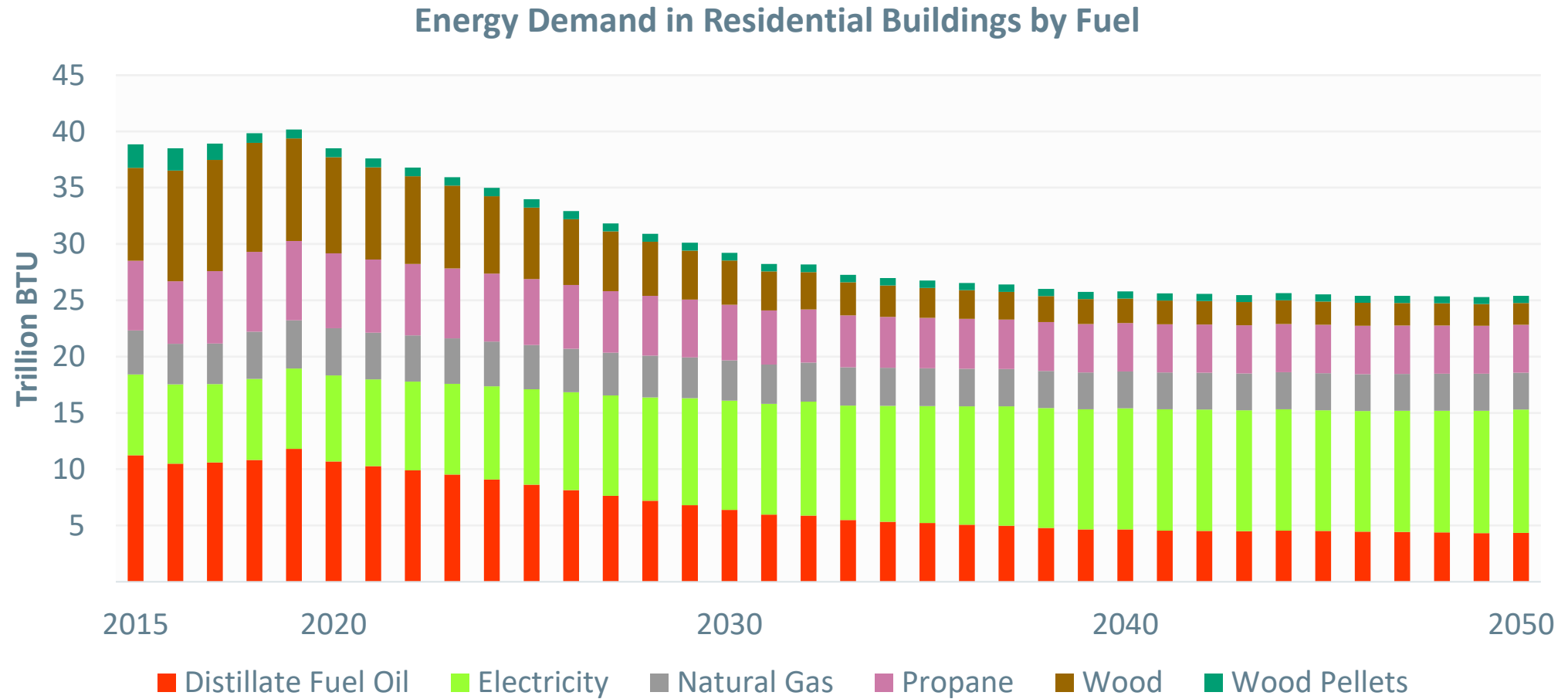
Residential Buildings: Reference Case Assumptions



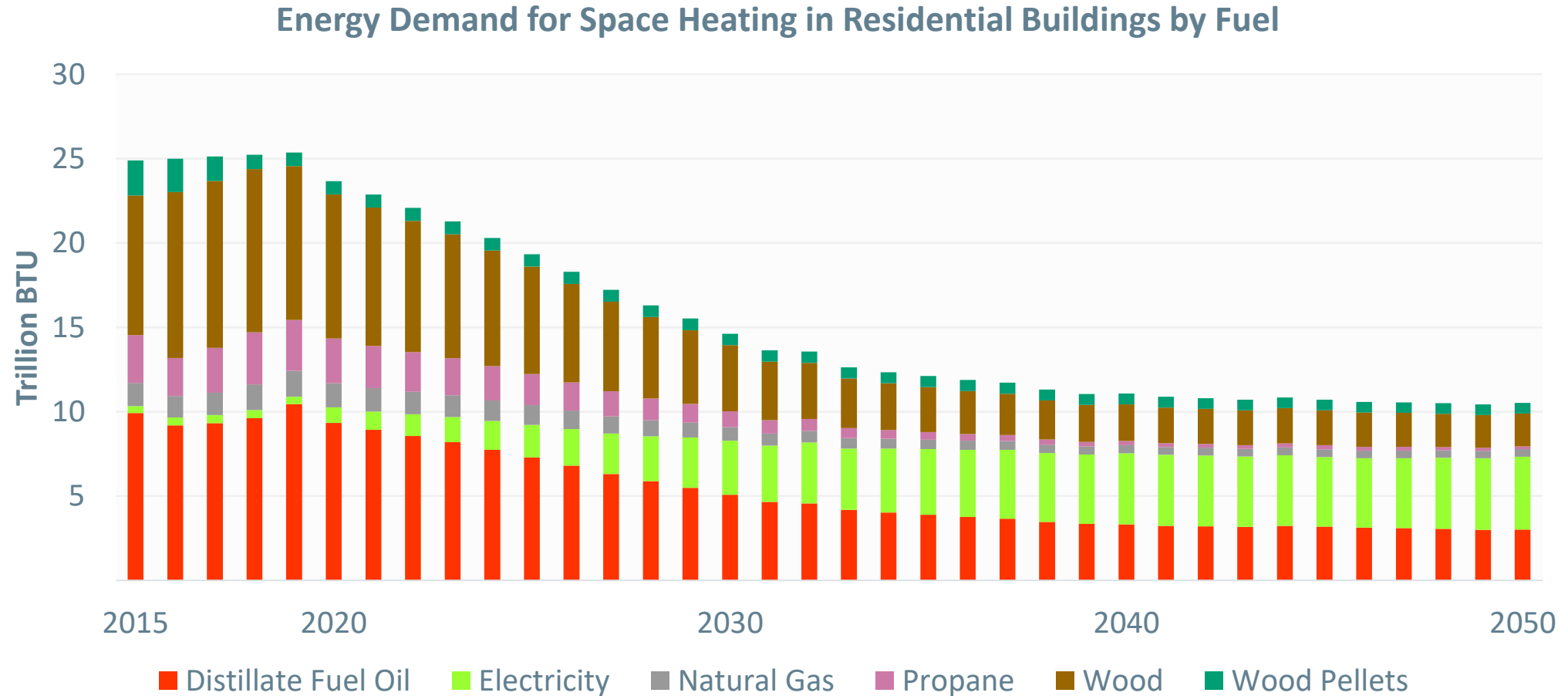
Residential Buildings: Reference Case Results



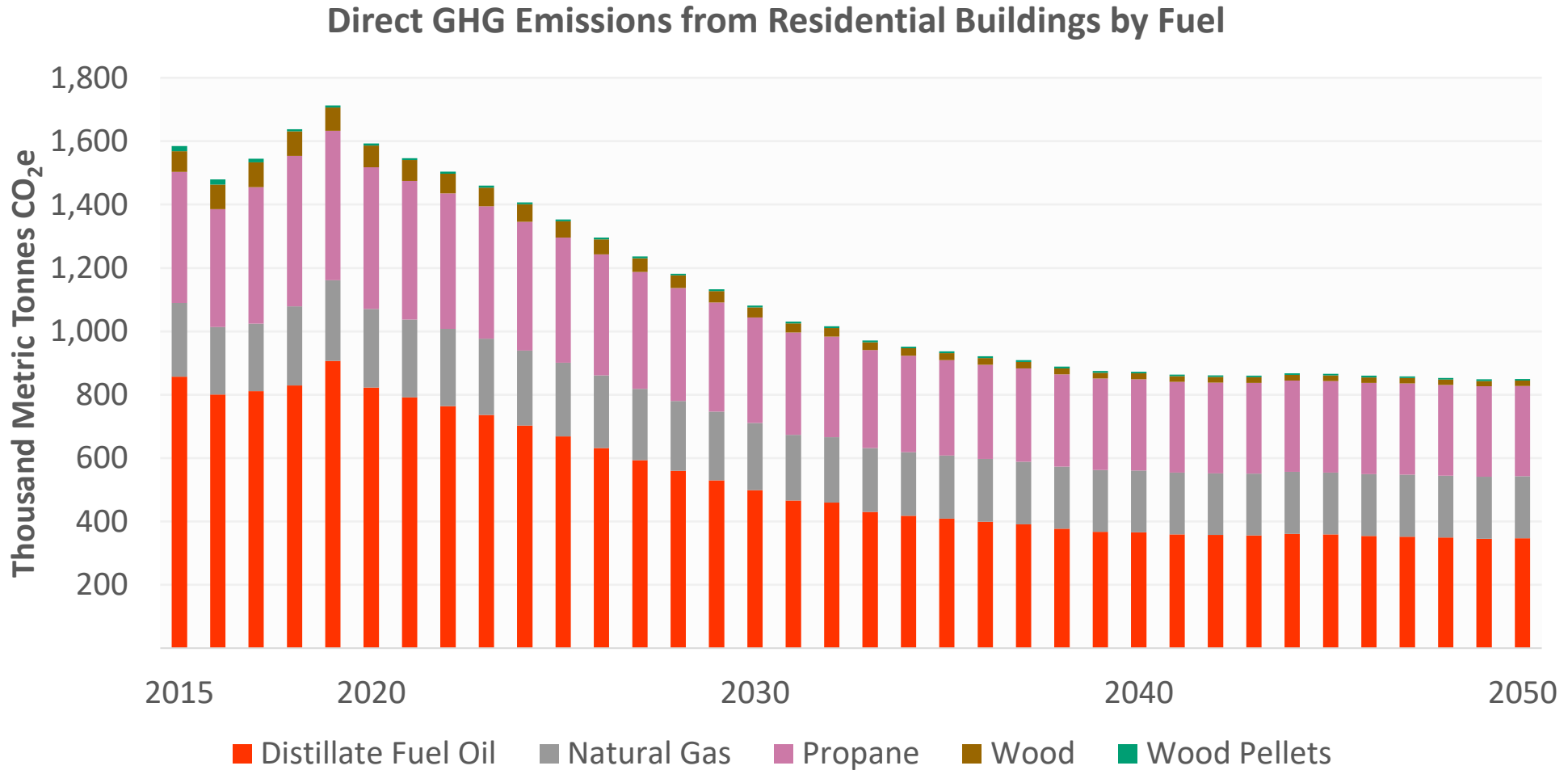
Residential Buildings: Reference Case Results



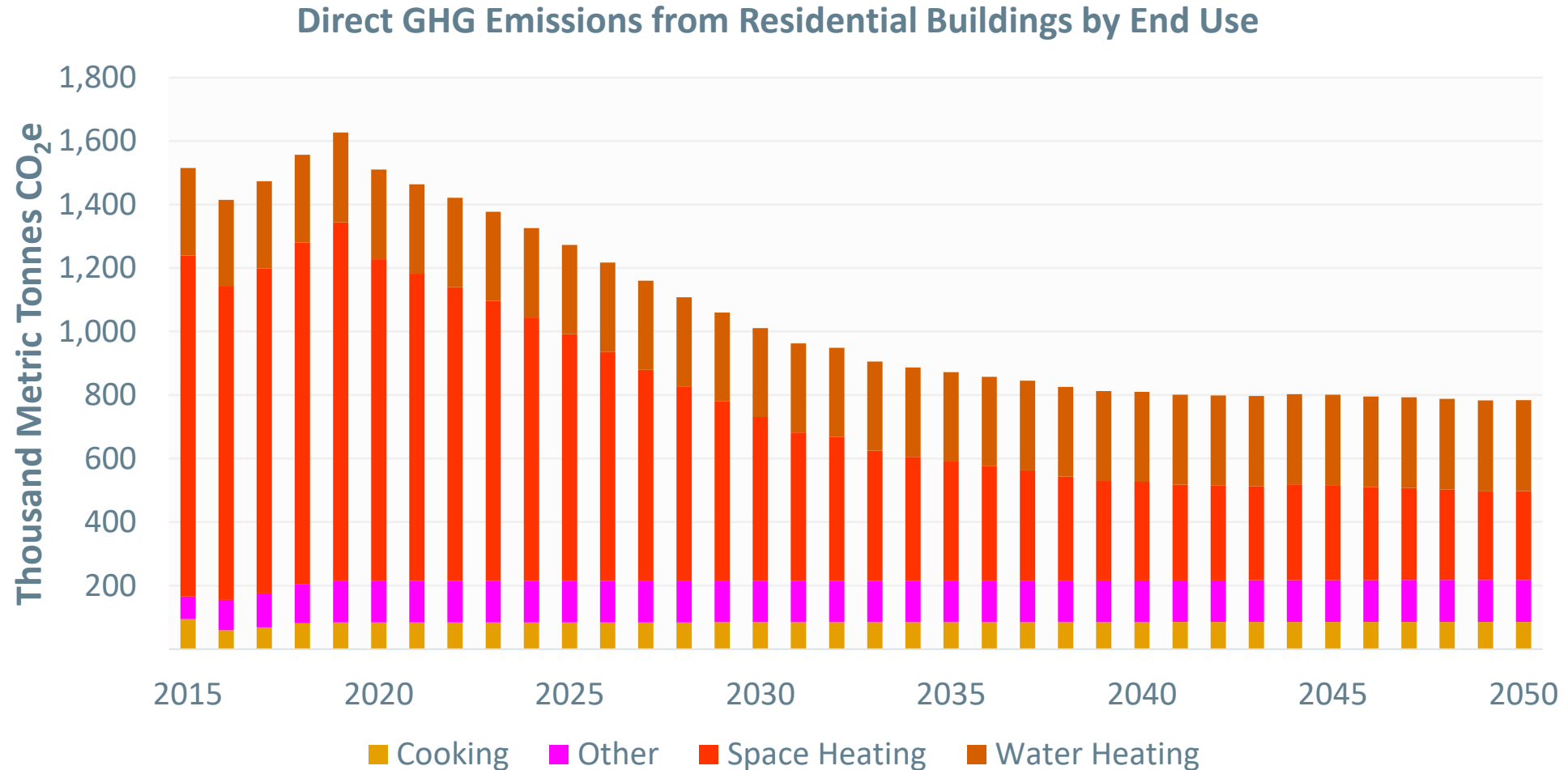
Residential Buildings: Reference Case Results



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Residential Buildings: Reference Case Results

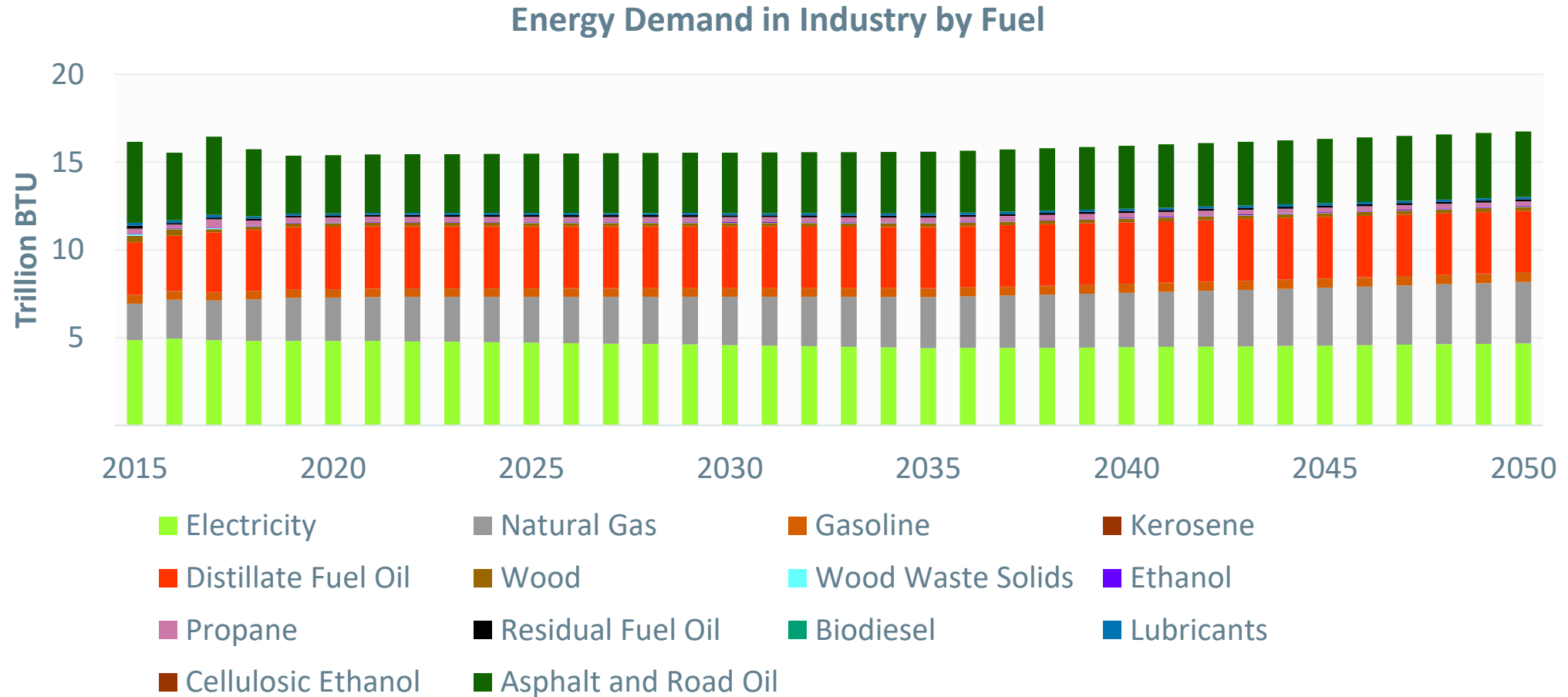


Industry

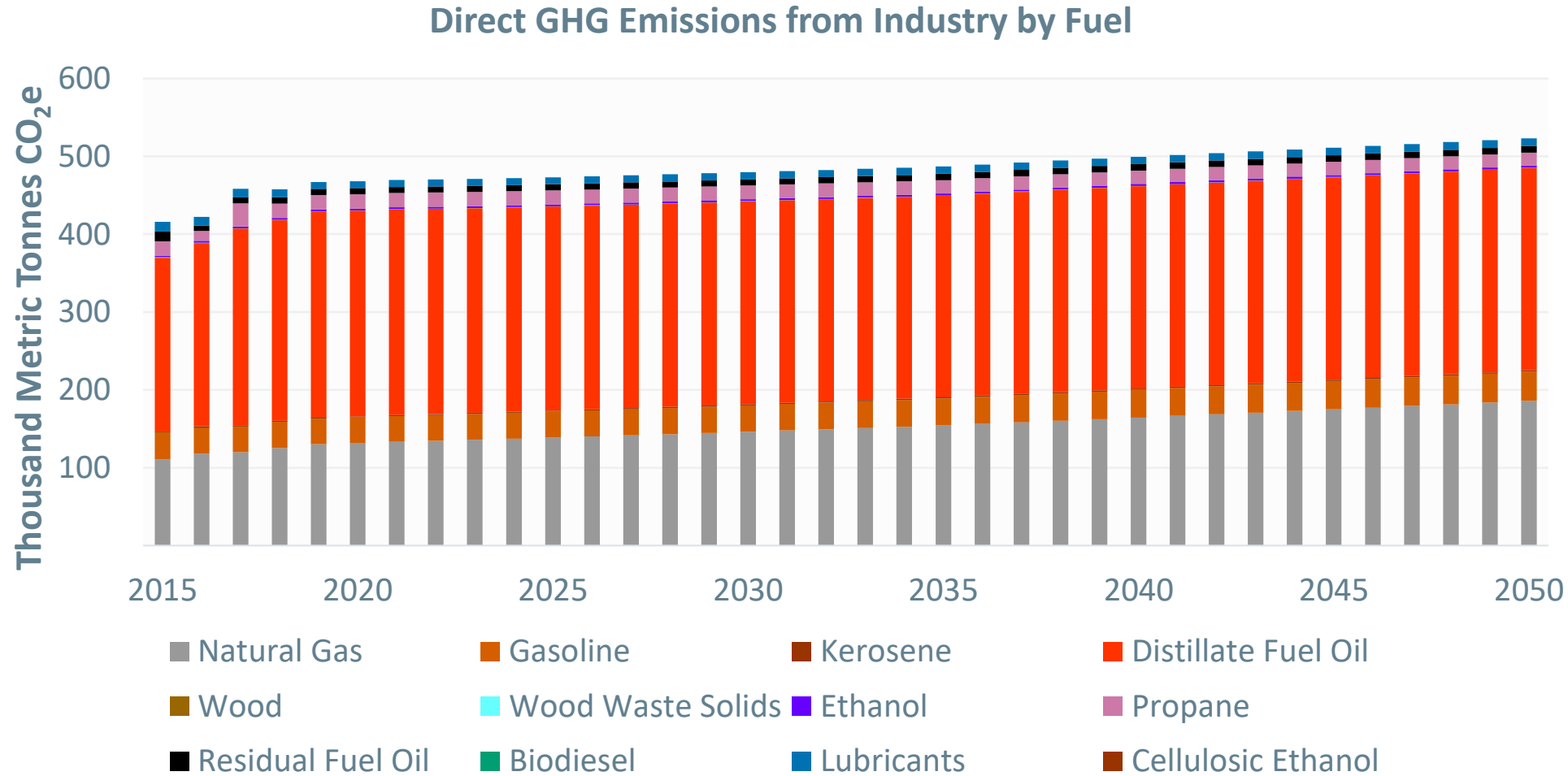
What's Included?

- Historical energy consumption by fuel from SEDS, with consumption forecasts aligned with AEO 2020
- AEO 2020: forecasted growth in final demands for each fuel
- Adjustments in natural gas, thermal fuels and electricity consumption to include forecasted energy efficiency programs from PUC and EVT
- GHG emissions from EPA's SIT

Industry: Reference Case Results



Industry: Reference Case Results



Total Emissions: Notes on Interpretation

In this draft version, **emissions from electricity consumption** are represented using a simplified consumption-based approach:

- Fixed amount of nuclear energy contracted to Vermont utilities for the duration of existing contracts (from PSD),
- Beginning 2017 and after, Vermont's Tier I and Tier II Renewable Energy Standard met using renewable energy,
- Remainder of electricity sourced from average grid mix:
 - Current GHG emissions from ISO-NE
 - Forecast GHG emissions decline assuming each state meets its own renewable portfolio standard

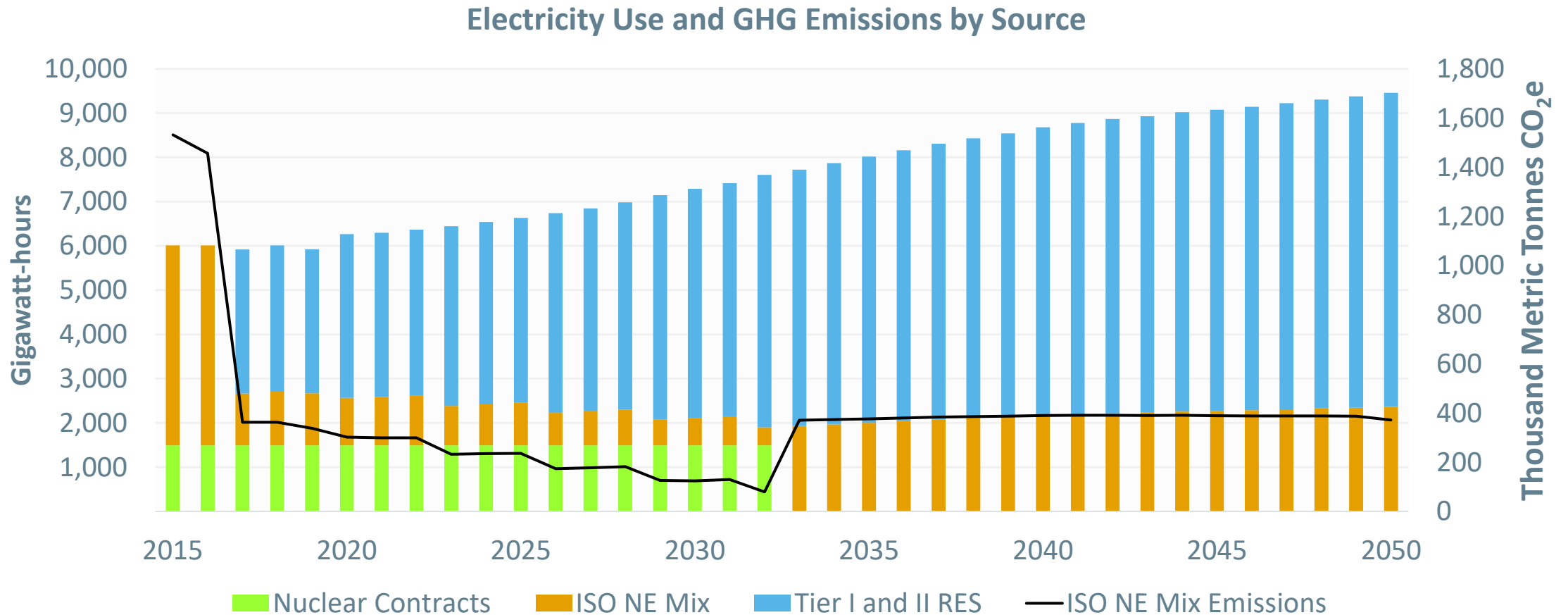
Subsequent versions of the model will simulate electric generation capacity and dispatch, by representing all different technologies (and imports) on the New England electric grid.

Total Emissions: Notes (continued)

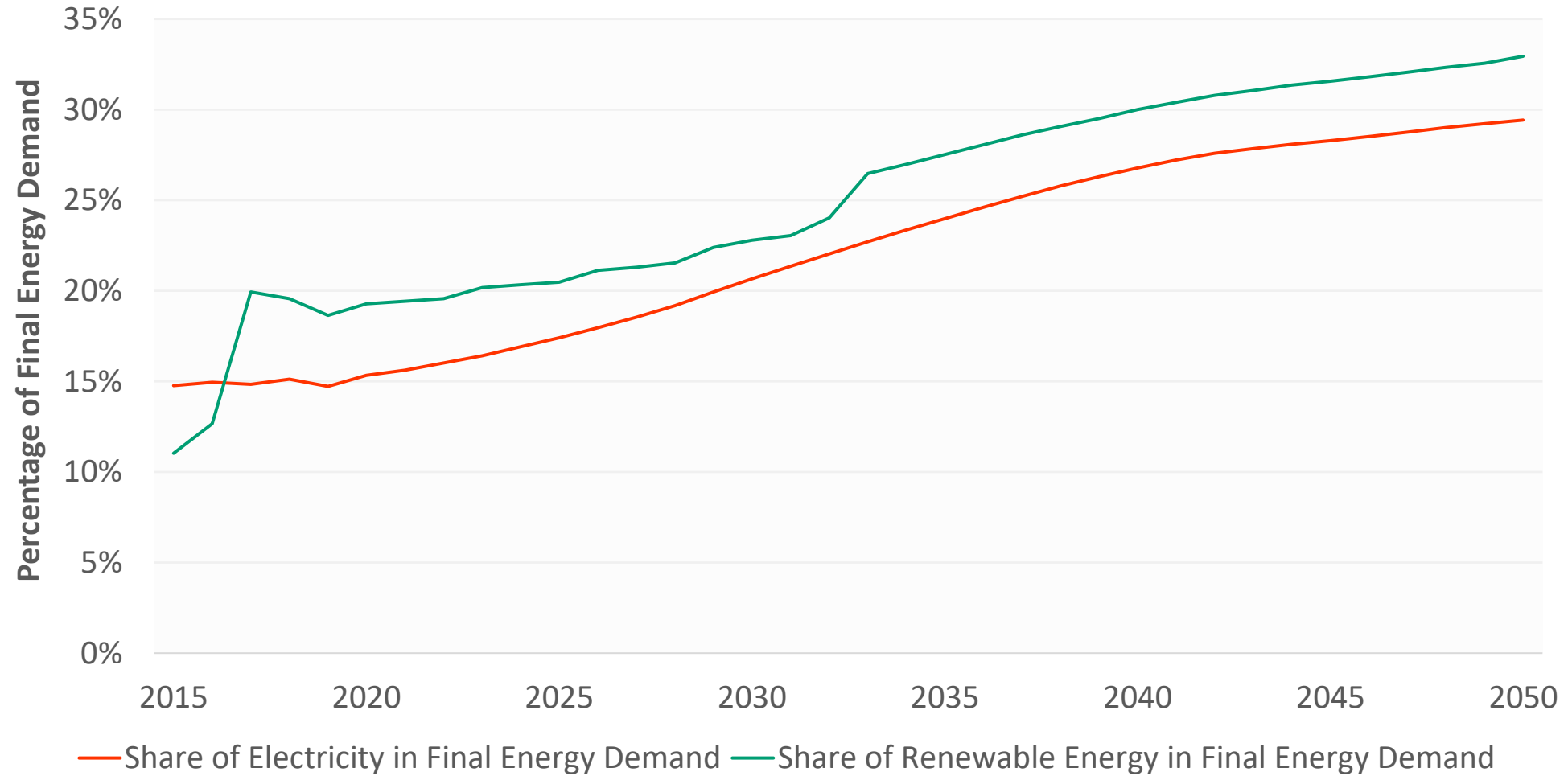
Non-Energy Emissions are also included:

- LEAP does not natively calculate non-energy emissions, but SEI has recreated some limited accounting calculations from EPA's SIT
- Industrial Processes and Produce Use (IPPU), Agriculture, Land Use, Land-Use Change and Forestry (LULUCF), Waste emissions are taken from EPA's SIT and Vermont AQCD
 - Simplified forecasts based on continuation of observed trends, or tied to change in population or state product (assumed 1.83%/yr growth)

Electricity Consumption: Reference Case Results



Electricity and Renewable Energy Shares: Reference Case Results



Total GHG Emissions and Targets

